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Salmonella awareness and related management practices in U.S. urban backyard chicken flocks

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ABSTRACT

Raising chickens in urban settings is a growing phenomenon in the United States. The United States Department of Agriculture's (USDA) National Animal Health Monitoring System (NAHMS) conducted a cross-sectional study to better understand health and management of privately owned chicken flocks, and *Salmonella* awareness among chicken owners, in three urban settings—Denver, Colorado; Los Angeles, California; and Miami, Florida. Feed stores in each city were visited by data collectors during summer 2010, and customers who owned chickens were asked to complete a questionnaire. A convenience sample of 449 feed store customers was selected, and 382 (85.1%) customers participated in the study. For analysis, a stratified random sample was assumed, with the strata being individual feed stores.

Median flock sizes were 5, 11 and 19 chickens in Denver, Los Angeles and Miami, respectively. In all three cities, over three-fourths of flocks contained table egg chicken breeds on the day the questionnaire was completed. In Denver, 20.4% of flocks had another species of bird present in addition to chickens, compared with 65.6% of flocks in Los Angeles and 53.6% of flocks in Miami.

At the time of data collection in 2010, less than 50% of respondents in Miami and Los Angeles (40.0 and 30.2%, respectively) were aware of a connection between poultry contact, such as contact with chicks or ducks, and *Salmonella* infection in people, compared to 63.5% of respondents in Denver. Urban chicken flock owners who completed the questionnaire in English were more likely to be aware of the connection between poultry contact and *Salmonella*, compared with respondents who completed the questionnaire in Spanish (OR = 3.5). The likelihood of *Salmonella* awareness was also higher for respondents who had heard of USDA's Biosecurity for Birds educational campaign and for respondents who sold or gave away eggs from their flocks (OR = 2.5 and 2.8, respectively).

Study findings demonstrate the importance of reaching the Spanish speaking population when creating educational outreach programs to reduce *Salmonella* infections in people who have live poultry contact.

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1. Introduction

Raising chickens in urban settings is a growing phenomenon in the United States. In recent years, a number of U.S. cities; including Columbia, Missouri, Ann Arbor, Michigan, Denver, Colorado, and Auburn, Alabama, have passed regulations allowing chickens to be kept at residences (Bartling, 2010). Consumer concerns about food quality and freshness, animal welfare, or consumer interest in local food production and sustainability may partially be driving the increasing popularity of urban backyard chicken flocks (Pollock et al., 2011; Stearns, 2010).

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Knowledge about the characteristics and management practices of noncommercial chicken flocks is useful for disease preparedness and response. These noncommercial flocks are sometimes involved in avian disease outbreaks. For instance, an economically costly outbreak of exotic Newcastle disease (END) in 2002–03 involved a number of backyard flocks in the Los Angeles, California, area (Pedersen et al., 2004). The USDA–APHIS previously conducted a study that addressed health, biosecurity, and bird movement practices of rural backyard flocks located within 1 mi of commercial poultry operations (Garber et al., 2007). Additionally, Donahue et al. (2011) and Yendell et al. (2012) studied management practices relevant to avian influenza in backyard poultry flocks in Wisconsin and Minnesota, respectively. However, none of these studies focused on chicken flocks in urban settings.

The increasing popularity of urban chicken flocks may also have public health implications (Pollock et al., 2011), since human salmonellosis outbreaks have been linked to contact with live poultry (CDC, 2000, 2009; Wilkins et al., 2002; Loharikar et al., 2012). *Salmonella enterica* can cause acute gastroenteritis and septicemia in humans. *S. enterica* infections are fairly common in domestic poultry throughout the world and infections in poultry are generally subclinical. Occasionally, infection causes diarrhea, loss of appetite, emaciation, and death in young chicks and poults. More often, *S. enterica* colonizes the intestinal tract of birds that become subclinical shedders of *Salmonella* in feces (Lutful Kabir, 2010). Humans are most likely to become infected with *Salmonella* from live poultry by the fecal-oral route. Although people of all ages can become ill, young children and the elderly are most at risk. Twenty-four percent of reported *Salmonella* cases in 2006 occurred in children under 5 years of age (CDC, 2008). For this reason, the CDC advises that children under 5 years of age should not handle poultry (CDC, 2009).

This study was conducted to gain insight about management and biosecurity practices of privately owned chicken flocks in three urban settings—Denver, Colorado, Los Angeles, California, and Miami, Florida, and to determine flock owners' awareness of the risk of *Salmonella* from contact with live poultry.

2. Methods

2.1. Data collection

This study was conducted by the United States Department of Agriculture's (USDA) National Animal Health Monitoring System (NAHMS). Four large cities were initially selected for inclusion in the urban chicken study: Denver, Colorado, Los Angeles, California, Miami, Florida, and New York City, New York. These cities were selected for geographic and demographic diversity. Locating chicken owners in these cities presented a unique challenge because a list of urban chicken owners was not available. Therefore, data collection was accomplished using a convenience sample of feed store customers.

Feed stores that sold chicken feed within the metropolitan area of the four selected cities were identified using public online directories and/or lists available to state or federal governments. All identified feed stores were contacted for participation. The only eligibility requirement for feed stores was that they estimated having at least five customers purchasing chicken feed on an average Saturday. This requirement was for efficient use of data collectors. Feed stores that agreed to participate were visited by APHIS and State data collectors, most often on Saturdays, from June to September, 2010. New York City was excluded from the feed store-based study because no feed stores meeting eligibility criteria were identified.

Feed store customers who entered participating feed stores while data collectors were present were asked to complete a confidential questionnaire about bird health, biosecurity, and movement practices. Customers were eligible to complete the questionnaire if they had at least one chicken on the day they were asked to complete the questionnaire, lived within a defined geographic area (or kept their chickens at a location within the defined geographic area), and lived on less than 1 acre of land if they lived in a single-family home. The latter two requirements were intended to limit the study to chicken owners in truly urban areas, as opposed to the outskirts of urban areas. For Los Angeles, the defined geographic area was all of Los Angeles County. The defined geographic areas for Denver and Miami are shown in Figs. 1 and 2.

Respondents were offered a $10 coupon toward their purchase at the feed store as an incentive to complete the questionnaire. The questionnaire took about 10 min to complete, was available in English and Spanish, and contained 31 questions that were primarily yes/no and multiple choice with an opportunity to write in explanations. Data collectors received formal training on administering the questionnaire and customer eligibility before visiting feed stores.

Assuming a response rate of 70%, a sample size of 285 chicken owners in each city was adequate to estimate prevalences of management practices (or flock characteristics) in each city of 50% (±6 to 7%) and 10% (±3 to 4%) with 95% confidence (CDC, 2005).

2.2. Data analysis

Data were entered into a SAS data set. Validation checks were performed to identify numeric extremes and improper categorical responses. For analysis, a stratified random sample was assumed, with the strata being individual feed stores. Statistical analysis was conducted using SAS-callable SUDAAN software, which accounts for the sampling design by use of the Taylor linearization method (LaVange et al., 1996).

A multivariable logistic regression analysis was performed to examine associations between flock characteristics and the respondents' *Salmonella* awareness. The respondent being aware of a connection between poultry contact, such as contact with chicks or ducks, and *Salmonella* infection in people, was used as the outcome variable. Independent variables associated ($p < 0.25$) with the outcome in bivariable analysis (adjusted for city) were offered for inclusion in the multivariable model. A backward elimination procedure was used to create the final multivariable model. City was forced into the final

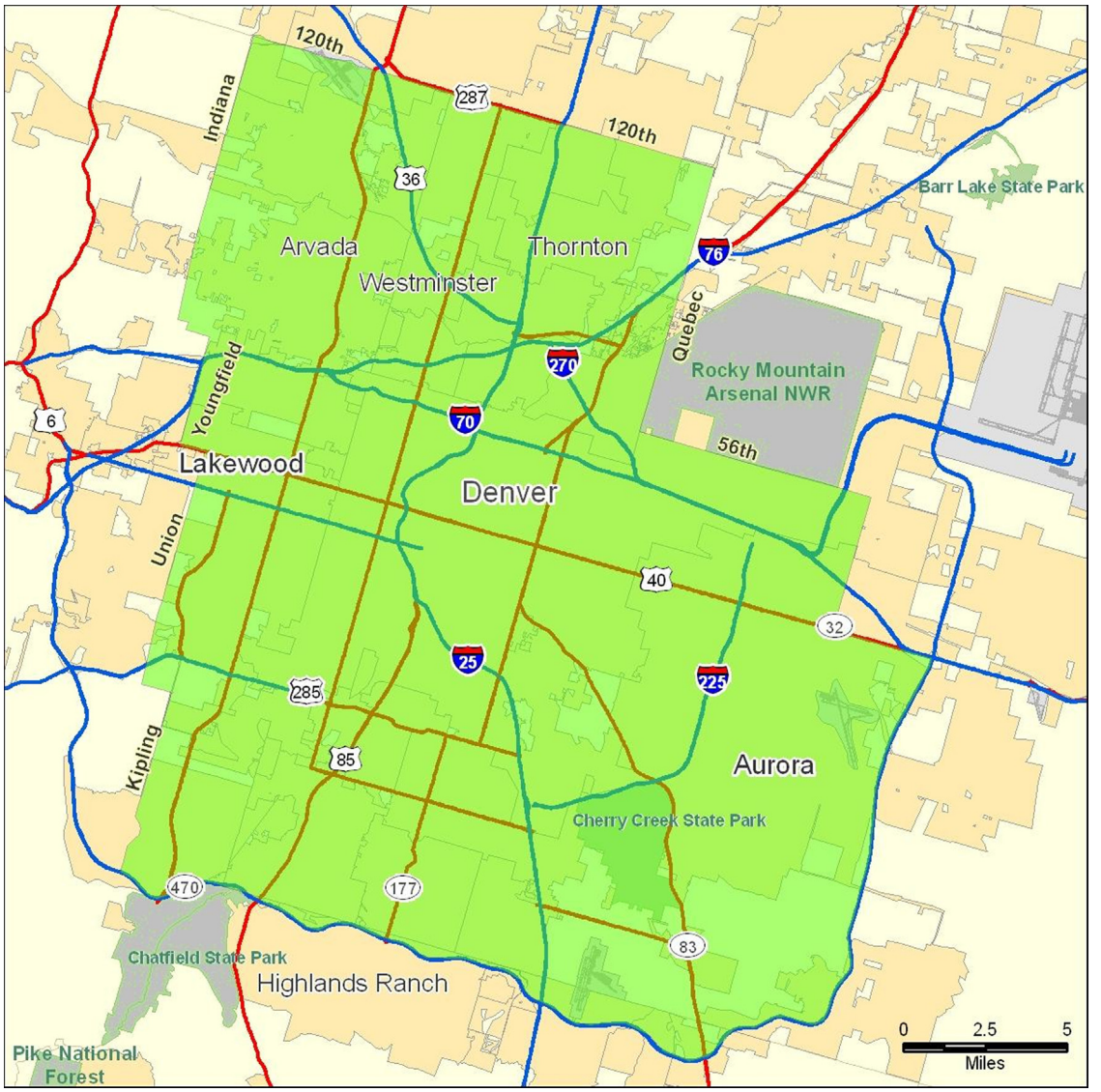

Fig. 1. Denver geographic area for the urban chicken study.

multivariable model as a fixed effect to control for confounding. Continuous independent variables that did not meet the assumption of linearity in the logit scale were converted to categorical variables. Variables with a Wald F p-value ≤ 0.05 were considered statistically significant. First order interactions were evaluated between city and the other fixed effects in the final model. Interactions with a Wald F p-value ≤ 0.10 were considered statistically significant. The Hosmer–Lemeshow chi-square goodness of fit statistic was used to assess model fit (SUDAAN version 10).

3. Results

3.1. Response rate

Response rates (number of respondents/number of eligible customers contacted in feed stores) were 93.8% (137/146), 85.5% (189/221), and 68.3% (56/82) in Denver, Los Angeles, and Miami, respectively, for a total of 382 completed questionnaires. In Denver, Los Angeles, and Miami, 6, 7, and 7 feed stores participated in the study, respectively. A half-day to day-long feed store visit by a data collector yielded on average 16 completed questionnaires.

3.2. Characteristics of urban chicken flocks

Median and interquartile range (IQR) for flock sizes in Denver, Los Angeles and Miami were 5 (IQR = 7), 11 (IQR = 18) and 19 (IQR = 37), respectively. The majority of flocks in Denver (69.3%) had 1 to 9 chickens, while over one-half of flocks in Los Angeles and Miami had 10 or more chickens. In Miami, 42.9% of flocks had 25 or more chickens (Table 1).

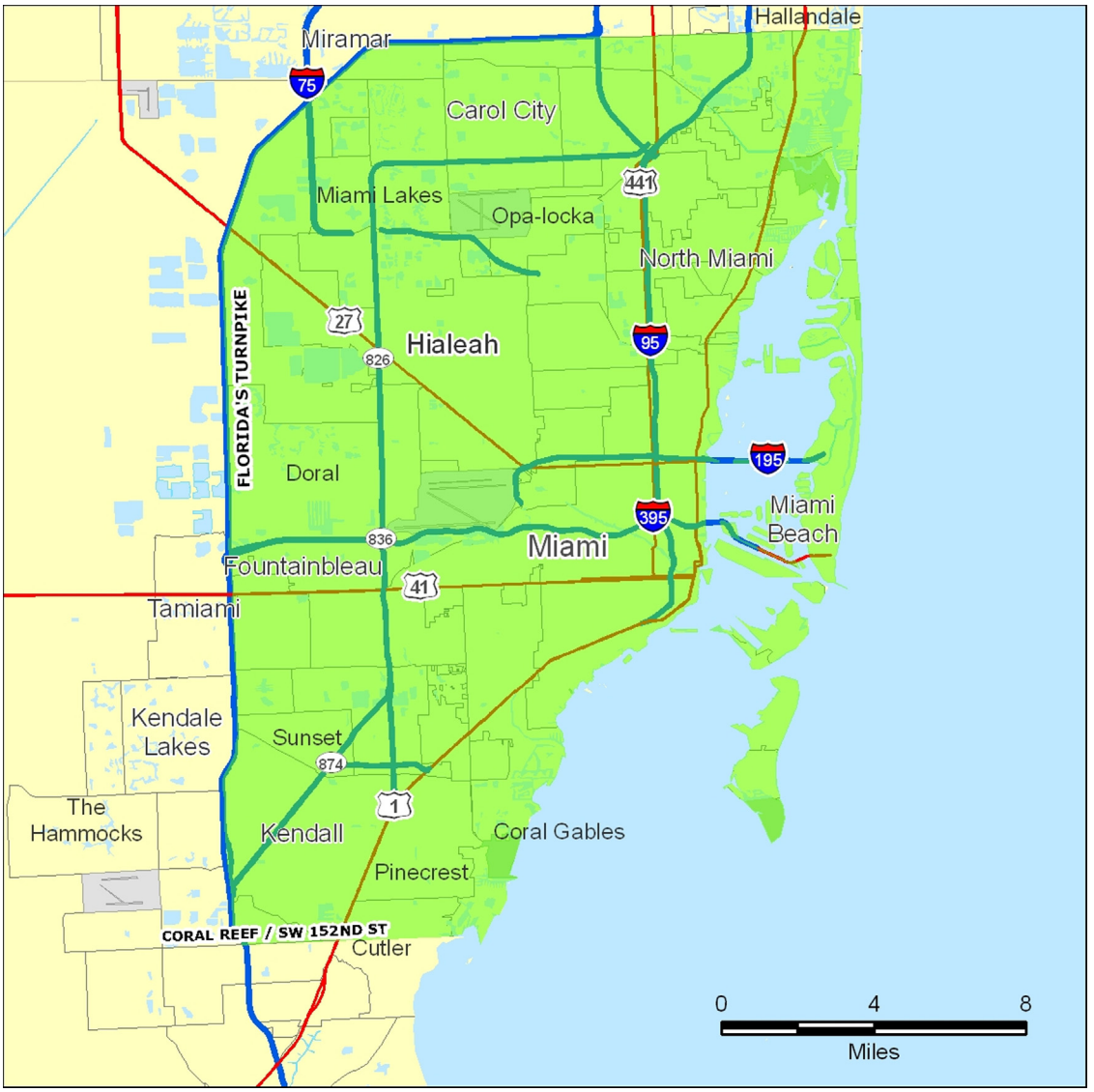

Fig. 2. Miami geographic area for the urban chicken study.

A lower percentage of flocks in Los Angeles (40.7%) and Miami (53.7%) had acquired new chickens in the previous 12 months compared with flocks in Denver (74.5%, Table 1). Data inspection revealed 46% of the chicken acquisitions in Denver were initial flock start-ups rather than addition of chickens to existing flocks. Less than one-fourth of flocks that obtained new chickens in the last year acquired them from a mail order/Internet source. A higher percentage of flocks in Los Angeles obtained new chickens from a feed store (55.6%) or local hatchery (33.3%), compared with flocks in Denver (29.3% and 13.1%, respectively; Table 1).

In all three cities, over three-fourths of urban chicken flocks contained table egg chicken breeds on the day the questionnaire was completed (Table 2). A higher percentage of flocks in Los Angeles and Miami had meat breeds of chickens (46.0% and 42.9%, respectively), pigeons/doves/game birds (36.0% and 33.9%, respectively), and pet birds (54.5% and 37.5%, respectively) compared with flocks in Denver (Table 2). In Denver, 20.4% of flocks had another species of bird present in addition to chickens, compared with 65.6% of flocks in Los Angeles and 53.6% in Miami.

Children under 5 years of age were present in the household for 15.4%, 37.3%, and 13.0% of flocks in Denver, Los Angeles, and Miami, respectively, and children under the age of 18 were present in the household for 46.3%, 71.4%, and 37.0% of flocks in Denver, Los Angeles, and Miami, respectively (Table 3). In Denver, 18.2% of respondents had heard of USDA's Biosecurity for Birds educational campaign compared with 34.1% of respondents in Los Angeles and 39.3% in Miami. Over one-half of flocks in each city ranked feed stores a very important source of information on chicken health (Table 3).

Table 1
Urban chicken flock characteristics, by city, and chi-square analysis for differences by city.

Characteristic	*n*	Percent flocks (standard error)			χ^2 *p*-value
		Denver	Los Angeles	Miami	
Flock size[a]	382				<0.0001
1–9		69.3 (3.8)	42.3 (3.3)	21.4 (5.7)	
10–24		19.7 (3.4)	32.8 (3.4)	35.7 (6.1)	
25 or more		11.0 (2.6)	24.9 (3.1)	42.9 (6.4)	
Total		100.0	100.0	100.0	
Acquired new chickens in last 12 months	380	74.5 (3.8)	40.7 (3.4)	53.7 (6.2)	<0.0001
Source of new chickens[b]					
Feed or farm store	177	29.3 (4.3)	55.6 (6.7)	20.8 (8.8)	0.0018
Internet/mail order	177	24.2 (4.3)	9.3 (4.0)	8.3 (5.8)	0.023
Local hatchery	177	13.1 (3.4)	33.3 (5.9)	33.3 (9.5)	0.0057
Any of the above	177	55.6 (4.9)	72.2 (6.0)	58.3 (10.1)	0.10
Other source	177	56.6 (5.0)	55.6 (6.5)	75.0 (8.6)	0.16
Sold or gave away eggs in the last 12 months	363	49.3 (4.3)	18.4 (2.9)	20.0 (5.5)	<0.0001
Had visitors enter chicken area in last 12 months	361	68.5 (4.0)	34.1 (3.4)	34.8 (7.2)	<0.0001
Always required hand washing after handling chickens	378	86.8 (2.9)	68.8 (3.2)	76.8 (5.1)	0.0002
Kept chickens in the house/living space in last 3 months	370	25.9 (3.8)	9.8 (2.2)	11.5 (4.5)	0.0011

n = number flocks.
[a] Maximum number of chickens kept at any one time during the previous 12 months.
[b] For the subset of flocks that acquired new chickens in the last 12 months.

Table 2
Percentage of flocks having the following types of birds on the day the questionnaire was completed, and chi-square analysis for differences by city (*n* = 381 urban chicken flocks[a]).

Bird type	Percent flocks (standard error)			χ^2 *p*-value
	Denver	Los Angeles	Miami	
Chickens: table egg breeds	96.3 (1.6)	79.9 (2.9)	78.6 (5.2)	<0.0001
Chickens: meat breeds	6.6 (2.2)	46.0 (3.4)	42.9 (6.6)	<0.0001
Chickens: game fowl	0.0 (–)	43.9 (3.2)	23.2 (5.7)	<0.0001
Chickens: others (show/exhibition)	16.2 (3.2)	23.8 (3.1)	21.4 (5.3)	0.23
Turkeys	2.2 (1.3)	17.5 (2.6)	14.3 (4.6)	<0.0001
Ducks/other waterfowl	11.0 (2.7)	18.5 (2.7)	23.2 (5.7)	0.054
Pigeons, doves, game birds	4.4 (1.7)	36.0 (3.2)	33.9 (6.1)	<0.0001
Guinea fowl	0.0 (–)	10.1 (2.1)	14.3 (4.7)	<0.0001
Pet birds	8.8 (2.4)	54.5 (3.6)	37.5 (6.2)	<0.0001
Any birds other than chickens	20.4 (3.4)	65.6 (3.3)	53.6 (5.7)	<0.0001

[a] One questionnaire had missing data for bird types.

Table 3
Flock owner characteristics, by city, and chi-square analysis for differences by city.

Characteristic	*n*	Percent flocks (standard error)			χ^2 *p*-value
		Denver	Los Angeles	Miami	
Ranked feed store a very important source for chicken health information	376	50.4 (4.3)	69.0 (3.3)	61.8 (6.4)	0.0028
Respondent had heard of USDA's Biosecurity for Birds educational campaign	378	18.2 (3.2)	34.1 (3.5)	39.3 (6.3)	0.0006
Children under 18 years old in household	375	46.3 (4.2)	71.4 (3.3)	37.0 (6.5)	<0.0001
Children under 5 years old in household	375	15.4 (3.2)	37.3 (3.5)	13.0 (4.1)	<0.0001
"Learning experience for kids" was an important[a] reason for having chickens	373	46.0 (4.2)	53.0 (3.6)	41.8 (6.8)	0.24
"Income" was an important[a] reason for having chickens	373	3.6 (1.6)	9.9 (2.2)	16.4 (4.8)	0.0081
"Food quality (e.g., freshness, health)" was an important[a] reason for having chickens	373	78.1 (3.5)	38.1 (3.6)	40.0 (6.4)	<0.0001
Respondent had raised chickens for 1 year or less	358	44.1 (4.3)	24.1 (3.0)	12.5 (4.8)	<0.0001
Questionnaire completed in Spanish (vs. English)	382	3.6 (1.0)	68.8 (2.6)	41.1 (6.5)	<0.0001

n = number flocks.
[a] The respondent selected a 4 or 5 on a scale of 1–5, with 1 being not important and 5 being extremely important.

3.3. Bivariable analysis of factors associated with respondent's awareness of the zoonotic risk of Salmonella from contact with live poultry

Of the 382 survey respondents, 374 (97.9%) answered a survey question asking if they were aware of any connection between poultry contact, such as contact with chicks or ducks, and *Salmonella* infection in people. Less than 50% of the respondents in Los Angeles and Miami (30.2 and 40.0%, respectively) were aware of the connection between *Salmonella* and poultry compared to 63.5% of respondents in Denver (Table 4). Flock size did not meet the assumption of linearity in the logit scale; therefore, it was analyzed as a categorical variable with three levels: 1–9,

Table 4
Percentage of respondents who were aware of a connection between poultry contact, such as contact with chicks or ducks, and *Salmonella* infection in people, and bivariable[a] analysis of factors associated with *Salmonella* awareness.

Factor	Level	*n*	Percent (SE)	Wald *p*-value
City	Denver	137	63.5 (4.2)	<0.0001[d]
	Los Angeles	182	30.2 (3.3)	
	Miami	55	40.0 (6.2)	
Flock size[b]	1–9	183	44.3 (3.5)	0.24[d]
	10–24	108	45.4 (4.6)	
	25 or more	83	41.0 (5.4)	
Questionnaire language	English	222	58.1 (3.3)	0.0001[d]
	Spanish	152	23.0 (3.4)	
Respondent had heard of USDA's Biosecurity for Birds educational campaign	Yes	108	52.8 (4.6)	0.0006[d]
	No	265	40.0 (2.9)	
Sold or gave away eggs in the last 12 months	Yes	107	64.5 (4.7)	0.0007[d]
	No	251	35.5 (2.8)	
"Learning experience for kids" was an important[c] reason for having chickens	Yes	178	50.0 (3.6)	0.0066[d]
	No	191	38.2 (3.3)	
"Income" was an important[c] reason for having chickens	Yes	31	54.8 (9.1)	0.034[d]
	No	338	42.9 (2.5)	
"Food quality (e.g., freshness, health)" was an important[c] reason for having chickens	Yes	196	52.6 (3.5)	0.13[d]
	No	173	34.1 (3.5)	
Had visitors enter chicken area in last 12 months	Yes	166	54.2 (3.8)	0.029[d]
	No	189	33.9 (3.3)	
Ranked feed store a very important source for chicken health information	Yes	228	42.1 (3.1)	0.68
	No	141	46.1 (4.0)	
Children under 18 years old in household	Yes	213	42.3 (3.3)	0.56
	No	158	46.2 (3.8)	
Children under 5 years old in household	Yes	95	40.0 (5.0)	0.70
	No	276	45.3 (2.8)	
Had table egg chicken breeds	Yes	320	45.9 (2.6)	0.54
	No	53	32.1 (6.4)	
Had meat chicken breeds	Yes	113	28.3 (4.2)	0.052[d]
	No	260	50.8 (3.0)	
Had game fowl chickens	Yes	91	33.0 (4.9)	0.72
	No	282	47.5 (2.8)	
Had other chickens (e.g., show/exhibition)	Yes	76	46.1 (5.5)	0.34
	No	297	43.4 (2.7)	
Had turkeys	Yes	42	23.8 (6.5)	0.097[d]
	No	331	46.5 (2.6)	
Had ducks/other waterfowl	Yes	61	34.4 (5.9)	0.24[d]
	No	312	45.8 (2.7)	
Had pigeons, doves or game birds	Yes	90	33.3 (4.9)	0.78
	No	283	47.3 (2.8)	
Had guinea fowl	Yes	27	33.3 (8.7)	0.98
	No	346	44.8 (2.5)	
Had pet birds	Yes	134	33.6 (4.0)	0.68
	No	239	49.8 (3.1)	
Respondent had raised chickens for 1 year or less	Yes	107	50.5 (4.7)	0.84
	No	247	42.9 (3.0)	

n = number flocks; SE = standard error.
[a] Adjusted for city.
[b] Maximum number of chickens kept at any one time during the previous 12 months.
[c] The respondent selected a 4 or 5 on a scale of 1–5, with 1 being not important and 5 being extremely important.
[d] Variables offered for inclusion in the multivariable model.

10–24 and 25 or more chickens. The following variables were associated ($p < 0.25$, on bivariable analysis adjusted for city) with awareness of the connection between poultry contact and *Salmonella*: city, flock size, questionnaire language, respondent awareness of USDA's Biosecurity for Birds educational campaign, selling or giving away eggs in the previous year, "learning experience for kids" being an important reason for having chickens, "income" being an important reason for having chickens, "food quality (e.g., freshness, health)" being an important reason for having chickens, having visitors enter the chicken area in the previous year, having meat chicken breeds, having turkeys, and having ducks/waterfowl (Table 4).

3.4. Multivariable analysis of factors associated with respondent's awareness of the zoonotic risk of Salmonella from contact with live poultry

When controlling for the other variables in the multivariable model (Table 5), respondents in Los Angeles were less likely to be aware of a connection between poultry contact, such as contact with chicks or ducks, and *Salmonella* infection in people compared with respondents in Denver (OR = 0.49). Respondents who completed the questionnaire in English were more likely to be aware of the connection compared with respondents who completed the questionnaire in Spanish (OR = 3.5). The likelihood of *Salmonella*

Table 5
Results of multivariable logistic regression analysis of factors associated with awareness of a connection between poultry contact and *Salmonella* infection in people ($n = 353$ urban chicken flocks).

Factor	Odds ratio	95% CI OR	Wald p-value
City			0.097
Denver	referent		
Los Angeles	0.49	0.25–0.94	0.031
Miami	0.72	0.35–1.5	0.37
Questionnaire language			0.0001
English	3.5	1.9–6.4	
Spanish	referent		
Respondent had heard of USDA's Biosecurity for Birds educational campaign			0.001
Yes	2.5	1.4–4.2	
No	referent		
Sold or gave away eggs in the last 12 months			0.0003
Yes	2.8	1.6–4.9	
No	referent		
"Learning experience for kids" was an important[a] reason for having chickens			0.025
Yes	1.8	1.1–2.9	
No	referent		

CI = confidence interval; OR = odds ratio.
[a] The respondent selected a 4 or 5 on a scale of 1–5, with 1 being not important and 5 being extremely important.

awareness was higher for respondents who had heard of USDA's Biosecurity for Birds campaign, for respondents who sold or gave away eggs from their flocks, and for respondents who rated "learning experience for kids" as an important reason for having chickens (OR = 2.5, 2.8, and 1.8, respectively). Interactions between city and the other fixed effects in the final model were not statistically significant. The Hosmer–Lemeshow goodness of fit test did not indicate a significant lack of fit for the model ($p = 0.54$).

4. Discussion

Study findings suggest limited awareness of the risk of human salmonellosis from contact with live poultry among urban chicken flock owners in 2010. Characteristics of urban chicken flocks, such as flock size and the types of chickens raised, differed between the 3 cities included in this study.

Since nonprobability sampling of feed store customers was used, results are not intended to make inference to the population of all urban chicken owners, but are intended to provide insight about the population which may be useful for disease preparedness and response planning, developing appropriate outreach programs and identifying general areas of concern. Furthermore, criteria for inclusion were dependent on visiting feed stores; therefore, results do not represent urban chicken owners who obtain feed from other sources or feed table scraps exclusively. Selection bias could have occurred since enumerators most often visited feed stores on Saturdays and since some feed stores refused to participate. Response rates for feed store customers varied between the cities. The low response rate in Miami could have introduced nonresponse bias. Despite the limitations of the nonprobability sampling, the results provide first insights into practices of urban chicken owners who purchase feed in local feed stores.

Locating urban chicken flock owners was challenging. In general, national lists or databases of chicken owners are not available, and lists were not available for the areas included in this study. Feed stores were theorized to be an effective way of locating urban chicken owners. We did not reach our goals for sample size in each city, because identifying chicken owners via feed stores proved to be more time consuming than anticipated. Most feed store owners were enthusiastic and cooperative. Therefore, we believe that feed stores can be an effective way to distribute information to chicken owners, especially printed educational materials that can be distributed by feed store employees. However, surveying urban chicken owners through feed stores is a moderately expensive method for data collection on this population.

In this study, flock owners who completed the study questionnaire in Spanish were less likely to be aware of the connection between poultry contact and *Salmonella* infection in people than respondents who completed the questionnaire in English. This finding highlights the importance of reaching the Spanish-speaking population when creating educational outreach programs to reduce poultry-associated *Salmonella* infections in people. On the other hand, flock owners who had sold or given away eggs in the 12 months prior to the survey were more likely to be aware of *Salmonella* risk from contact with live poultry. Since eggs have been implicated in food-associated *Salmonella* outbreaks in humans, flock owners who distribute eggs may be more aware of poultry-related *Salmonella* in general.

In a case control study, CDC (2000) found that washing hands after handling poultry prevented human illness during a 1999 salmonellosis outbreak. In the present study, 86.8%, 68.8%, and 76.8% of flocks in Denver, Los Angeles, and Miami, respectively, always required hand washing after handling chickens. Flocks in Los Angeles were less likely to require hand washing than flocks in Denver, which may be related to the lower awareness of *Salmonella* risk in Los Angeles compared with Denver. In comparison, Yendell et al. (2012) found that 77.3% of backyard flocks surveyed in Minnesota in 2007–08 always required hand washing after handling birds, and USDA (2005) found that only 40.2% of rural backyard flocks surveyed in 18 states in 2004 always required hand washing after handling birds. Awareness of the importance of hand washing may be

increasing over time, since less than half of flock owners in 2004 required the precaution, compared with about three-fourths of flock owners in the later surveys. However, the three studies may not be comparable since each study had a different target population and different methodology. Continued educational efforts emphasizing the importance of hand washing for chicken owners in all three cities, especially Los Angeles, are needed based on the results of this study.

In 2011, the Centers for Disease Control released an educational document in English and Spanish (CDC, 2011) for public education on the risk of human salmonellosis from contact with live poultry. In the present study, the majority of chicken owners who acquired new chickens obtained them from either a feed store, a local hatchery, or through mail order. Therefore, distribution of the CDC educational document through feed stores and hatcheries should be an effective way to reach many urban chicken owners and to protect public health. Additionally, over half of urban chicken owners considered feed stores to be a very important source of chicken health information, further emphasizing the opportunity to educate chicken owners by partnering with feed store owners. Loharikar et al. (2012) described four multistate outbreaks of human salmonellosis from contact with live poultry, and similarly concluded that feed stores can play an important part in reducing human cases of *Salmonella* from live poultry.

In summary, this study reveals limited awareness among urban chicken flock owners in 2010 of the risk of human salmonellosis from contact with live poultry, and demonstrates the importance of reaching the Spanish-speaking population when creating educational outreach programs to reduce poultry-associated *Salmonella* infections in people. Future studies are suggested to reevaluate the percentage of urban chicken owners who are aware of the connection between poultry contact, such as contact with chicks or ducks, and *Salmonella* infection in people, in order to assess the effectiveness of educational campaigns. Future studies exploring the prevalence and risk factors for shedding of *Salmonella* in U.S. backyard flocks would also help define and mitigate the public health risk.

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